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Description

PICK-RESISTANT WAFER TUMBLER LOCK WITH SIDEBARS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of United States Patent Application Serial No. 10/187,727, filed on July 2, 2002, which claims priority to United States Provisional Patent Application Serial No. 60/302,643, filed July 2, 2001. This application also claims priority to United States Provisional Patent Application Serial No. 60/439,956 filed January 14, 2003.

BACKGROUND OF INVENTION

[0002] The invention relates to a pick-resistant locking mechanism, and more specifically to a locking mechanism with wafer tumblers and sidebars that interact to provide pick-resistant features.

[0003] Pin-tumbler locking mechanisms contain a cylinder plug which rotates within a tightly-fitting cylindrical housing or shell. Channels containing elongated top and bottom pin

tumblers extend perpendicularly through the cylinder plug and shell. The pin tumblers slide up and down within the channels to provide for a locked and unlocked position. When the top or bottom pin tumbler spans both the cylinder plug and shell, the pin tumbler is in a position of interference and the cylinder plug is locked and therefore unable to rotate within the shell. When the correct key is inserted into the keyway of the lock, the notches on the key contact the bottom pin tumblers and slide the pin tumblers within the channels so that the entire length of the bottom pin tumbler is positioned within the cylinder plug at its outside diameter. As such, the pin tumblers are in a position of non-interference, and the cylinder plug is unlocked thereby allowing the cylinder plug to rotate within the shell when rotational torque is applied by the key.

[0004] Locks can be picked, or opened without a key. Figures 1A-1G illustrate one conventional lock picking technique. As shown in Figure 1, a lock housing or shell A is provided with a rotateable cylinder plug B housed therein. A set of channels C extend through the shell A and cylinder plug B and contain spring-loaded pin tumblers D. In the locking mechanism shown in Figure 1, the pin tumblers D have

two parts which can separate when aligned along the shear line E by the correct key (not shown). In order to pick the lock, a tension wrench F is inserted into the keyway G of the lock, as shown in Figure 1B, and rotational torque is applied to the cylinder plug B. Since the pins D are in a position of interference with the cylinder plug B and shell A, the cylinder plug B is unable to rotate within the shell A. However, due to imperfections and misalignments in the mechanism, the torque applied by the tension wrench F can cause slight rotation of the cylinder plug B which results in small offsets between the channels C in the cylinder plug B and the shell A. This offsetting of the channels C creates a ledge along the surface of the channels C along the shear line E.A pick H is then inserted into the keyway G and used to slide one of the pin tumblers D up its respective channel C so that the end of the pin tumbler D rests on the ledge created along the shear line E, as shown in Figure 1C. Continued application of the rotational torque causes the pin tumbler D to remain wedged in this position of non-interference. As shown in Figures 1D-1F, the pick H is then used to position each of the other pin tumblers D on the ledge one at a time. As shown in Figure 1G, once all of the pin tumblers D are po-

sitioned on the ledge, the cylinder plug B can rotate within the shell A, thereby allowing the locking mechanism to be unlocked.

[0005] An alternative to the pin-tumbler lock is the wafer-tumbler locking mechanism. Wafer-tumbler locks require less strict tolerances between components and, therefore, are advantageous in that they are more economical to manufacture than pin tumbler locks. Wafer tumbler locks have thin wafer-shaped tumblers which slide up and down within slots that span both the cylinder plug and shell. The wafer tumblers are spring loaded so that they extend out of the cylinder plug and into a cavity within the lock shell. In this position of interference, the extended wafer tumblers prevent rotation of the cylinder plug within the shell. The center of each of the wafer tumblers has an opening so that a key can be inserted into the keyway and through the wafer tumblers. The correct key contacts the wafer tumblers and moves the wafer tumblers within the slots so that they are retracted from the cavity within the lock shell and positioned within the cylinder plug. So positioned, the wafer tumblers are in a position of non-interference and rotational torque applied to the cylinder plug causes its rotation within the shell and unlocking of

the mechanism. Insertion of an incorrect key into the lock keyway will not result in placement of the wafer tumblers in a position of non-interference.

[0006] Since wafer tumbler locks are easier to pick, its resistance to picking can be increased by placing a second locking feature within the lock. One such locking feature that has been used in the past is a spring-loaded sidebar. A sidebar is positioned within its own slot in the cylinder plug, the slot cut perpendicular to the slot within which the wafer-tumblers slide. Positioned within a sidebar slot, a sidebar can contact a wafer tumbler. Two types of sidebar can be used, those that are sprung away from the tumblers and those that are sprung toward the tumblers. There are distinct advantages to using the type that is sprung toward the tumblers. For example, a sidebar that is sprung away from the tumblers can be forced into the tumblers and into a position of non-interference by the application of rotational torque. On the other hand, a sidebar that is sprung toward the tumblers will not seat properly in the tumbler upon the application of rotational torque. When the wafer tumbler is in a position of interference, the wafer tumblers contact with the sidebar prevents the sidebar from withdrawing from the cavity within

the shell. So positioned, the sidebar spans the cylinder plug and shell and keeps the cylinder plug from rotating within the shell. When the wafer tumbler is in a position of non-interference, the wafer tumbler contact with the sidebar is changed such that the sidebar is no longer held within the cavity of the shell and therefore does not span the cylinder plug and shell. When the sidebar is so positioned, rotational torque causes the cylinder plug to rotate within the shell.

[0007] Although wafer-tumbler locks are more economical to produce and are of smaller size than some other tumbler locking mechanisms, pin-tumbler locks for example, they are typically less resistant to picking than pin-tumbler locks. There is a need for a wafer-tumbler locking mechanism that is more pick-resistant.

SUMMARY OF INVENTION

[0008] A pick-resistant locking mechanism including wafer tumblers and sidebars is provided. In one embodiment, the sidebars have projections with beveled sides that engage with cavities in the lock shell when rotational torque is applied in the absence of the correct key. The tolerance between the sidebar and the lock shell is less than the tolerance between tumblers and the lock shell. When rota-

tional torque is applied in the absence of the correct key, the tolerance difference provides for engagement of the sidebar projections with the cavities of the lock shell before tumblers engage with the lock shell.

[0009] In another embodiment, each sidebar contacts two, non-adjacent wafer tumblers. An important aspect of the present invention is that the tumbler springs are not accessible from the keyway of the lock. In such an arrangement, the tumbler springs cannot be displaced, thereby allowing movement of the tumblers, by an attack from the keyway. Furthermore, in one embodiment, the tumbler springs are more powerful than the sidebar springs making it impossible to align the tumbler cutout for the sidebar with the projection on the sidebar without continuous support of the tumbler in the proper position. Additionally, tumbler indentations may be included to engage shell projections when rotational torque is applied to the cylinder in the absence of the correct key.

[0010] Another aspect of the present invention is a pick-resistant wafer cylinder lock that includes an interchangeable cylinder that allows rapid re-keying of the lock by swapping of one cylinder for another.

[0011] Still, other advantages and benefits of the invention will

be apparent to those skilled in the art upon reading and understanding of the following detailed description.

Brief Description of Drawings

[0012] The present invention may be more readily understood by reference to the following drawings. While certain embodiments are shown as illustrative examples of the invention, the scope of this application should not be construed as limited to these illustrative examples.

[0013] *Figures 1A-1G* are cross-sectional views of a conventional locking mechanism illustrating a typical lock picking technique.

[0014] *Figure 2* is an exploded view of the wafer lock of the present invention.

[0015] *Figure 3* is a view of the wafer lock of the present invention.

[0016] *Figure 4* is a front view of a wafer tumbler of the wafer lock.

[0017] *Figure 5* is a view of a sidebar of the wafer lock.

[0018] *Figure 6* is cross-sectional view of the cylinder assembly and shell of the wafer lock.

[0019] *Figure 7* is a cross-sectional view of the interchangeable cylinder assembly partially inserted into the shell.

[0020] *Figure 8* is a view of the interchangeable cylinder assembly partially inserted into the shell.

[0021] *Figure 9* is a view of the cylinder assembly fully inserted and partially rotated within the shell of the wafer lock.

[0022] *Figure 10* is a top view of the cylinder assembly shown in Figure 9.

[0023] *Figure 11* is a cross-sectional view of a lock assembly including raised edges that engage the sidebars.

DETAILED DESCRIPTION

[0024] The present invention is a wafer tumbler locking mechanism, generally referenced as *100*, including a lock body or shell *102*, a lock cylinder *104*, a set of spring-loaded wafer tumblers *106* and a set of spring-loaded sidebars *110*. Optionally, the wafer lock may also include a cylinder door *118*, cylinder door spring *120* and cylinder cap *122* which assemble into a cylinder plug *104* front opening *124*. The cylinder cap *122* contains an opening *126* into which a key *130* is inserted.

[0025] As shown in Figure 4, the wafer tumblers *106* are generally flat rectangular-shaped pieces that are arranged within a set of tumbler slots *132*. While the wafer tumblers *106* are shown and described as flat, generally rectangular pieces, it should be appreciated that the wafer tumblers *106* can

be a variety of shapes, sizes and configurations providing the wafer tumblers *106* still provide the functional aspects as described herein. Each wafer tumbler *106* has an opening *134* through the center of the tumbler though which a key *130* is inserted. These openings *134* are configured to mate with a key *130* such that when a key *130* is inserted through the keyway *131* and the openings *134* the notches in the key contact the upper edge *136* of the tumbler opening and thereby move the tumbler *106*, as discussed in further detail below. Each wafer tumbler *106* has a spring tab *138* that protrudes from one side of the wafer tumbler *106* and contacts one end of the spring *140*. The other end of the spring *140* contacts a surface*142* of the cylinder *104*, thereby biasing the wafer tumbler *106* into engagement with the shell *102* as discussed below.

[0026] The wafer tumbler *106* also has a sidebar tab *144* protruding from the opposite side of the wafer tumbler *106* from the spring tab *138*. The sidebar tab *144* includes cutout *146* for engaging the sidebar *110*. While the cutout *146* is shown as a pointed recess within the sidebar tab *144*, it should be appreciated that cutout *146* may also be rounded or contain different types of surfaces; however the cutout *146* should be configured to provide solid mat-

ing engagement with the sidebar *110*. The wafer tumbler sidebar tab *146* may contact a sidebar *110* at a geometrically inversed projection*148* located on the sidebar*110*. The projection *148* is used to maintain contact between the sidebar tab *144* and the sidebar *110*.Wafer tumblers *106* may further include indentations *150* in one end of the tumbler *106* that form a camming surface with the lock shell *102*. The indentations *150* are generally located along the bottom *152* of the wafer tumbler *106* which engages the lock shell *102* when the wafer tumbler *106* is in the locked position, as discussed below.

[0027] The sidebars *110*, shown in detail in Figure 5, are rectangular with a rounded projection *160* with beveled sides *162* that forms a camming surface with the interior of the shell *102*. The length of the sidebars *110* depend on the number of wafer tumblers *106* the sidebar interacts with. In one embodiment, the sidebars *110* are long enough to engage the two or more wafer tumblers *106* in every other fashion. While the wafer tumbler to sidebar ratio may be 1:1, it is preferable to have such ratio be 2:1, or greater, to further provide anti-picking protection. The sidebar *110* has a sidebar recess*163* which spans the area where the wafer tumbler spring *140* of the intervening wafer tumbler *106* is

located. The sidebar *110* has a tumbler projection *148*,located on either side of the recess*163*,which contacts non-adjacent wafer tumblers *106*.As mentioned above, the projection *148* contacts the sidebar tab *144* of the wafer tumbler *106* at the sidebar tab cutout *146*. This wafer tumbler sidebar tab cutout *146* is located at various positions along the wafer tumbler sidebar tab *144*. Each different position is aligned with the sidebar tumbler projection *148* by the notches on the key *130* at a different depth. As described above, contact between the tumbler projection *148* of the sidebar *110* and the wafer tumbler *106* determines whether the sidebar *110* is in a position of interference or non-interference with the lock shell. The separation of the sidebar *110* into two portions with the sidebar rounded projection *160* between them allows a rocking or pivoting motion in the sidebar *110* that decreases the ability of the sidebar *110* to seat in the sidebar cutouts*146*of both wafer tumblers *104*simultaneously unless positioned by a key *130*. The sidebar is held in place within the cylinder *104* by sidebar springs *166*, one end of which contacts the sidebar *110* at the blind hole *168* located at each end of the sidebar *110*.

[0028] The wafer tumblers *106* andsidebars *110* fit into a cylinder

plug *104*, the wafer tumblers *106* generally located in the center of the cylinder plug *104* located in wafer slots *132*, and the sidebars located between the wafer tumblers *106* and the lock shell *102*. Optionally, a set of sidebar mounting plates *170* can be used to position the sidebars *110* into position between the wafer tumblers *106* and lock shell *102*. The sidebars *110* are placed in the sidebar slots *172* located between the wafer tumblers *106* and the lock shell *102*.

[0029] The lock shell *102* includes a top cavity *180*, two side cavities *182*, and a bottom cavity *184*. Each of the shell cavities have a set of projections that act as a camming surface to prohibit rotation of the lock cylinder. Specifically, the top cavity *180* has a set of top projections *186*, the side cavities *182* have a set of side projections *188*, and the bottom cavity has a set of bottom projections *190*. As assembled, and in the locked position, both the tumblers *106* and the sidebars *110* extend from the cylinder assembly *100* into cavities in the lock shell *102*. So positioned, the tumblers *106* and sidebars *110* are in a position of interference with the lock shell *102*, preventing rotation of the cylinder assembly *100* within the lock shell *102*. When rotational torque is applied to the cylinder assembly *100* in the ab-

sence of the correct key, camming of the rounded projections *160* of the sidebars with projections *188* adjacent to side cavities *182* in the interior sides of the lock shell *102* results in pulling of the sidebars *110* farther into the shell side cavity *182* thereby locking the sidebars *110* in a position of interference with the shell *102*. Likewise, when rotational torque is applied, in the absence of the correct key, camming of indentations *150* of the wafer tumblers *106* with projections *190* of the lock shell *102* adjacent to top cavity *180* or the bottom cavity *184* of the lock shell *102* results in preventing the wafer tumblers *106* from being moved toward the shell top cavity *108* or farther out of the shell bottom cavity *184* therein locking the wafer tumblers *106* in a position of interference with the shell *102*. Additionally, to further prohibit rotation of the cylinder *104*, the tolerance between the sidebars *110* and the lock shell *102* may be less than the tolerance between the wafer tumblers *106* and the shell *102*. Therefore, when rotational torque is applied to the cylinder assembly *100* in the absence of the correct key *130*, the beveled sides *162* of the sidebars *110* engage with the lock shell *102* before the indentations *150* of the wafer tumblers *106* engage with the lock shell *102*. This feature prevents positioning

of the wafer tumblers *106* in a position of non-interference by resting the ends of the tumblers *106* on the ledge of the shell *102* along the shear line. Furthermore, the spring force exerted by springs *140,* which hold the wafer tumblers *106* in position, may be greater than the spring force exerted by springs *166*, which hold the sidebars *110* in position. Providing a greater spring force on springs *140*, as compared to springs *166*, prevents the use of the sidebars *110* as a means for maintaining the wafer tumblers *106* in position of non-interference. As such, if a wafer tumbler *106* was moved to a position wherein it no longer interferes with the shell *102* in bottom shell cavity *184*, and therefore allowing the sidebar *110* to move into position against the sidebar tab *144* of the wafer tumbler wherein the sidebar *110* moves to a position wherein it no longer interferes with the shell *102* in the side cavity *182*, the spring force exerted by spring *140* would overcome the spring force exerted by spring *166* and the wafer tumbler *106* would spring back into the bottom cavity *184* of the shell *102*.

[0030] As shown, both the wafer tumbler *106* and the sidebar *110* are in a position of interference with the shell *102*. Therefore, the locking mechanism is in the locked position. The

cross-sectional view of Figure 6 shows the wafer tumbler *106* assembled into the cylinder plug wafer slot *132* of the cylinder plug *104* with the wafer tumbler spring *140*. The wafer tumbler spring *140* holds the wafer tumbler *106* in a position of interference with the shell *102*, as shown by the wafer tumbler bottom end *152* positioned into the shell bottom cavity *184*. The sidebar pointed projection *148* of the sidebar *110* contacts with the wafer tumbler sidebar tab *144* of the sidebar *110*. The sidebar spring *166* pushes against the sidebar *110* to continually force the sidebar *110* toward the wafer tumbler *106*. When the wafer tumbler sidebar cutout *146* is not aligned with the sidebar projection *148*, as shown in Figure 6, the sidebar projection *160* extends into the shell side cavity *182* to prevent rotation of the cylinder plug *102*.

[0031] When rotational torque is applied to the interchangeable cylinder assembly *100*, by an incorrect key for example, the interchangeable cylinder assembly *100* will not rotate due to the interference between the shell*102* and the wafer tumblers *106* and the sidebars *110*. When rotational torque is applied to the locking mechanism, without use of the correct key, the beveled side of rounded sidebar projection*162* contacts and cams with theshell side projection*188*

and pulls the sidebar projection*160* into the shell side cavity*182*. Additionally, when rotational torque is applied to the lock, in the absence of the correct key, the wafer tumbler indentations*150* engage with the shell bottom projections*190*. This engagement prevents upward movement of the wafer tumbler *106* into a position of non-interference. To further prevent the possible picking of the lock, the tolerance between the sidebars *110* and the shell *102* may be less than the tolerance between the wafer tumblers *106* and the shell*102* . Therefore, when rotational torque is applied in absence of the correct key, thesidebar projection *160* engages with the shell*102*before the wafer tumbler *106* engages with the shell*102*. Since the wafer tumbler *106* fails to contact the shell*102*, it is not possible to wedge the wafer tumbler *106* into a position along a ledge that is created along the shear line, as is attempted when the lock is picked.

[0032] If the correct key *130* is inserted into the keyway *131* of the interchangeable cylinder assembly *100*, the cuts on the key will position the wafer tumbler *106* within the cylinder plug *104* so that the ends of the wafer tumbler *106*, the wafer tumbler top end *194* and the wafer tumbler bottom end *152*, become flush with the outside diameter of the

cylinder plug *104* and, at the same time, align the wafer tumbler sidebar cutout *146* with the sidebar pointed projection *148*. When the sidebar pointed projection *148* is aligned with the wafer tumbler sidebar cutout *146*, the sidebar *110* moves inward until the beveled side of rounded sidebar projection *162* is also flush with the outside diameter of cylinder plug *104*. At that point, rotational torque applied to the key *130* causes the cylinder plug *104* to rotate within the shell *102*, thereby unlocking the wafer tumbler locking mechanism.

[0033] Locking mechanisms are contemplated that have between 4 and 11 wafer tumblers *106* and between 2 and 5 sidebars *110*. If the locking mechanism also comprises the interchangeability feature, whereby one interchangeable cylinder assembly *100* can be removed from the lock shell *102* and replaced with another interchangeable cylinder assembly *102* for the purposes of re-keying the lock, then an additional tumbler, called a shell locking tumbler *202* is used in the design.

[0034] Figures 7, 8, 9 and 10 are views of the interchangeable cylinder assembly *100* and surrounding lock shell *102*. These figures particularly show the features of the interchangeable cylinder feature of the lock. Figure 7 is a

cross-sectional view of the interchangeable cylinder assembly *100* in the unlocked position and partially inserted into the shell *102*. The cylinder plug retainer lugs*200* are aligned and inserted into the shell through the wafer cavities *180* and *184*. The interchangeable cylinder assembly *100* is inserted into the shell*102* in the direction of the arrow. Also shown is a shell locking tumbler*202* which is a single wafer at the end of the cylinder plug *104* that is nearest to the cylinder plug retainer lugs*200*. The shell locking tumbler*202* locks the interchangeable cylinder assembly *100* into the shell *102* after it has been completely inserted therein. Figure 7 shows a rear view of the interchangeable cylinder assembly *100* being inserted into the shell*102*. In this view, the interchangeable cylinder assembly *100* has been almost pushed all the way into the shell *102*. The cylinder plug retainer lugs*200* are shown aligned with the wafer cavities *180* and *184*. Figure 8 shows a view of the interchangeable cylinder assembly *100* partially inserted. Once completely inserted, the interchangeable cylinder assembly *100* is rotated such that the cylinder plug retainer lugs*200* are offset from wafer cavities *180* and *184*. In this position, the interchangeable cylinder assembly *100* cannot be pulled out of the shell*102* without

rotating the interchangeable cylinder assembly *100* back to a position where the cylinder plug retainer lugs*200*align with wafer cavities *180* and *184*in the shell*102*. Once the interchangeable cylinder assembly *100* is positioned within the shell*102* as shown in Figure 9, a special key can be inserted into the keyway *131* of the lock, causing retraction of the shell locking tumbler*202* into the lock cylinder plug *104* . In this position, the interchangeable cylinder assembly *100* can be removed from the shell*102* of the lock.

[0035] An additional feature of the lock is that the cylinder assembly *100* is easily removable from the lock shell *102* and replaceable with a different cylinder assembly *100* for the purpose of re-keying the lock. The cylinder plug *104* has cylinder plug retainer lugs*200* at the end opposite from the end where the key*130* is inserted. These retainer lugs *200* are important to the interchangeability of the interchangeable cylinder assembly *100* as they are different widths and will only allow the cylinder plug to be removed with a certain orientation. The interchangeable cylinder assembly *100* can easily be removed from the shell*102* and a different interchangeable cylinder assembly *100* can be inserted. The interchangeable cylinder assembly *100* is locked into place within the shell*102* by a shell locking

tumbler*202*. This interchangeability feature allows rapid re-keying of the lock.

[0036] The description above generally disclosed an interchangeable cylinder design for a cylinder that rotated 180 degrees to move the lock from the locked position to the unlocked position, or vice versa. Some locks do not require 180 degrees of rotation in order to move the lock between the locked and unlocked positions. Some locks use only 45 degrees or rotation, while others use 90 degrees of rotation. Other locks may require 360 degrees of rotation. Still other locks may require some other degrees of rotation, not stated above. As such, it is desirable to provide an interchangeable lock that can accommodate each of these degrees of rotation.

[0037] In order to make the mechanism compatible with the other locking mechanisms that require different degrees of cylinder rotation in order to move the lock from the locked position to the unlocked position, the embodiment shown in Figure 11 is used.

[0038] As shown in Figure 11, cylinder cavity *300* is not continuous from the front of the lock to the back of the lock. Instead, the cylinder cavity *300* is interrupted by a raised surface or ledge *305* within the lock shell *310*. The ledges

305 prevent the cylinder plug *320* from being removed from the lock shell *310* unless the sidebars *325* are retracted within the cylinder plug *320*. In the prior embodiments, the sidebars required alignment of the projection *160* with the shell side cavity *182*. This limits the degrees of rotation between the locked and unlocked positions. In the embodiment shown in Figure 11, the sidebars *325* do not include a projection that must be aligned, but instead interfere with ledge *305* regardless of orientation. As such, the cylinder plug *320* can have any degree of rotation between the locked and unlocked positions desired. The interference between the sidebars *325* and the ledge *305* assists in retaining the cylinder plug *320* in the shell *310*. As with the other embodiments, a shell locking tumbler and retainer lugs are used to secure the plug *320* within the shell and to orient the plug *320* during insertion of removal to avoid misalignment of the plug and the locking mechanism with the lock.

[0039] In order to remove the lock cylinder, a special tool must be used. This tool, in addition to the extra length required to reach the shell locking tumbler *330*, has the correct key bitting combination to move the wafer tumblers *340* and sidebars *325* to a position of non-interference (i.e. to open

the lock). This tool allows the sidebars *325* to retract completely within the plug *320* and, the extra length causes retraction of the shell locking tumbler *330*.